Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2019					

HIT235 – Digital Systems and Computer Architecture	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has one section.
Note that questions ARE NOT of equal value.
Read ALL questions carefully.
Answer ALL questions.
Total marks for this examination: 100

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1 (3 marks)

An automated thunderstorm warning system is required. Thunderstorms not only cause the risk of lightning strikes, they can also cause destructive winds and heavy rain, resulting in flash flooding. However not all thunderstorms are equally dangerous. You are asked to design a warning system that warns people of dangerous thunderstorms. If there is no risk of lightnings strikes, destructive winds or heavy rain, a green light should be on. If there is risk of lightning strikes but not of heavy rains or destructive winds an orange light should be on. If there is a risk of lightning strikes and heavy rain a red light should be on. The red light should also be on if there is a risk of lightning strikes as well as destructive winds. If there is a risk of lightning strikes, heavy rain and destructive winds all at once an "thunderstorm alert" sign should be switched on as well as the red light. Design the logic circuit for this system. Clearly label all inputs and outputs for your circuit.

Question 2 (3 marks)

Explain the difference between BCD code and binary code in words.

Question 3 (4 marks)

Form the 2's complement of the following numbers:

a) 11010

b) 00101101

Question 4 (3 marks)

Why are hexadecimal numbers widely used in computer and microprocessor applications?

Question 5 (4 marks)

A NAND gate is sometimes called a universal gate.

a) Draw the symbol of a NAND gate. (1 mark)

b) Draw a diagram showing how NAND gates can be used to make an AND gate. (1 mark)

c) Draw a diagram showing how NAND gates can be used to make an OR gate. (2 marks)

Question 6 (4 marks)

Figure 1

For the gate shown in Figure 1:

a) Give the truth table (2 marks)

b) Draw a diagram of an alternative symbol for this gate (2 marks)

Question 7 (3 marks)

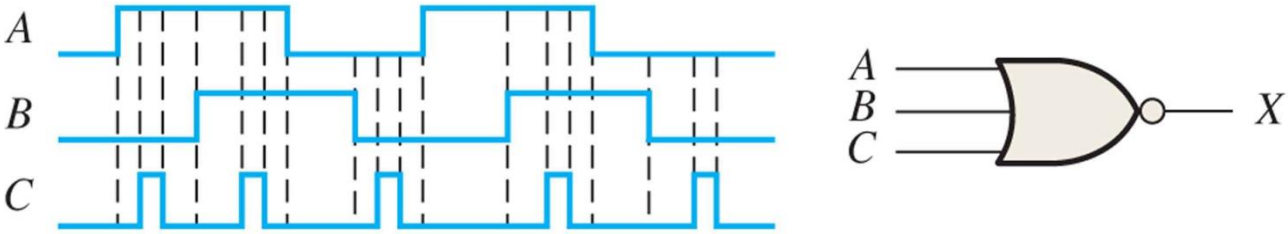

Figure 2

For the set of input signals shown in Figure 2, determine the output of the gate shown and draw the timing diagram.

Question 8 (3 marks)

A light switch alarm for a car should be on when the headlights are on, the ignition is switched off and the door is open. It should be off at all other times. How would you implement this?

Question 9 (3 marks)

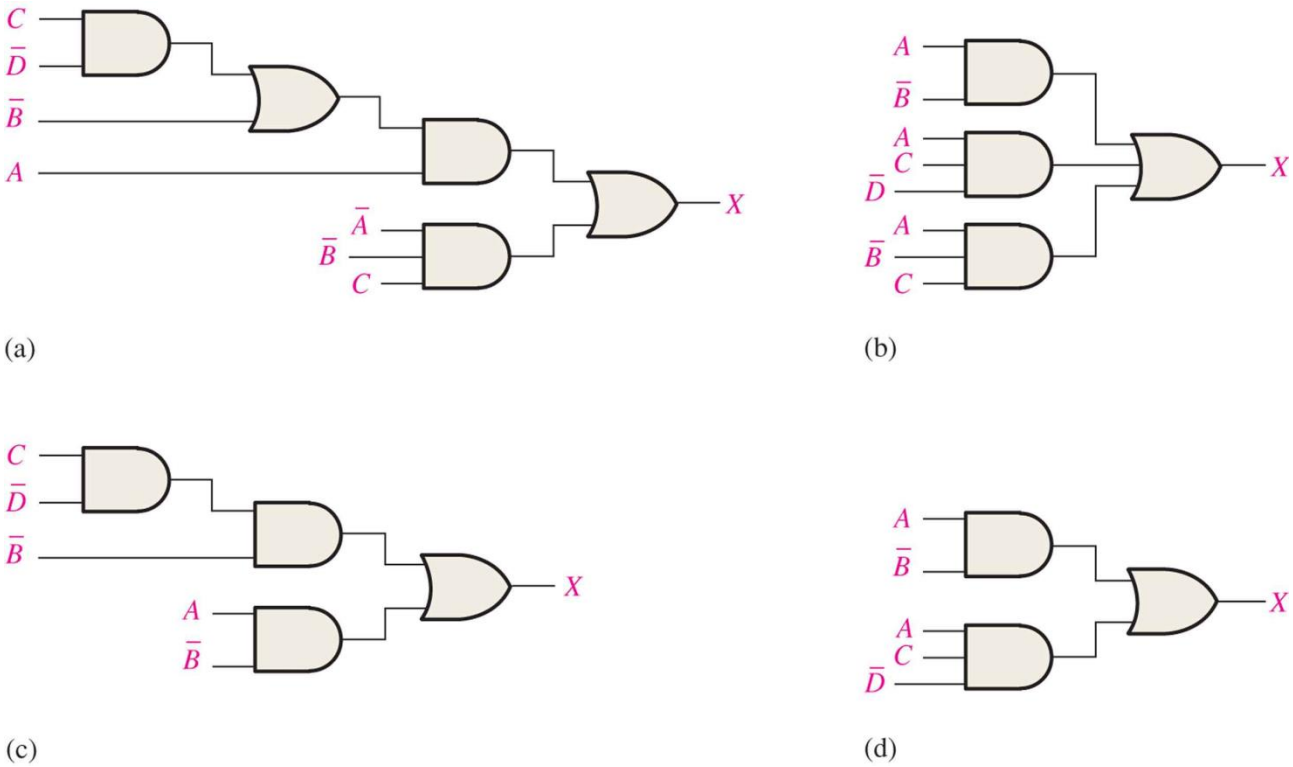

Figure 3

Determine which of the circuits in Figure 3 are equivalent.

Question 10 (6 marks)

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

Table 1

For the truth table shown above,

a) Derive the Sum Of Product (SOP) and a standard Product Of Sums (POS) expression.

b) Use a Karnaugh map to find the minimum SOP expression.

Question 11 (4 marks)

Apply DeMorgan's theorems to simplify the following expressions:

a) $\overline{\overline{AB}(CD+\overline{EF})(\overline{AB}+\overline{CD})}$

b) $\overline{\overline{(A+B)}\overline{(C+D)}\overline{(E+F)}\overline{(G+H)}}$

Question 12 (3 marks)

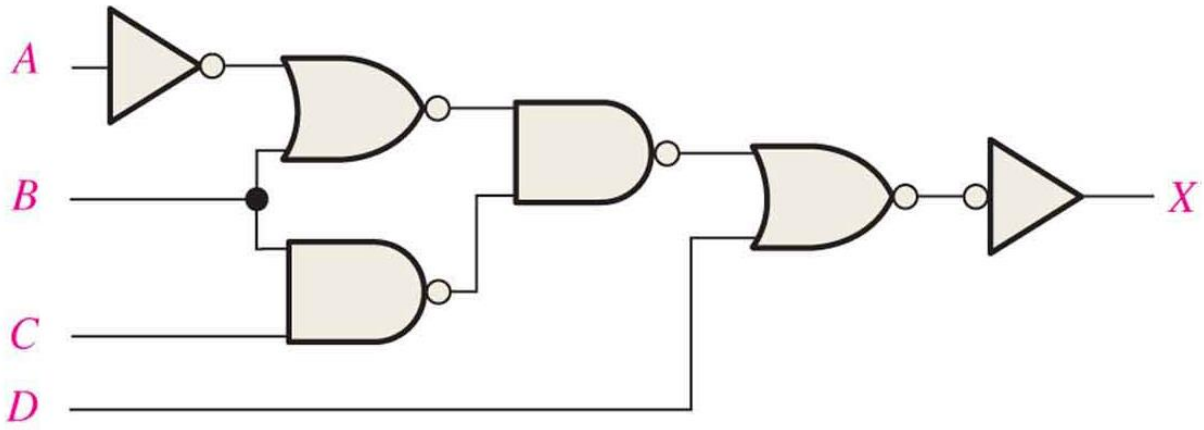

Figure 4

Write the output expression of the circuit shown in Figure 4.

Question 13 (4 marks)

a) Give the truth table for a full adder. (2 marks)

b) Show how two full adders can be combined to make a 2 bit binary adder. (2 marks)

Question 14 (3 marks)

What is the difference between an astable multivibrator and a monostable multivibrator?

Question 15 (3 marks)

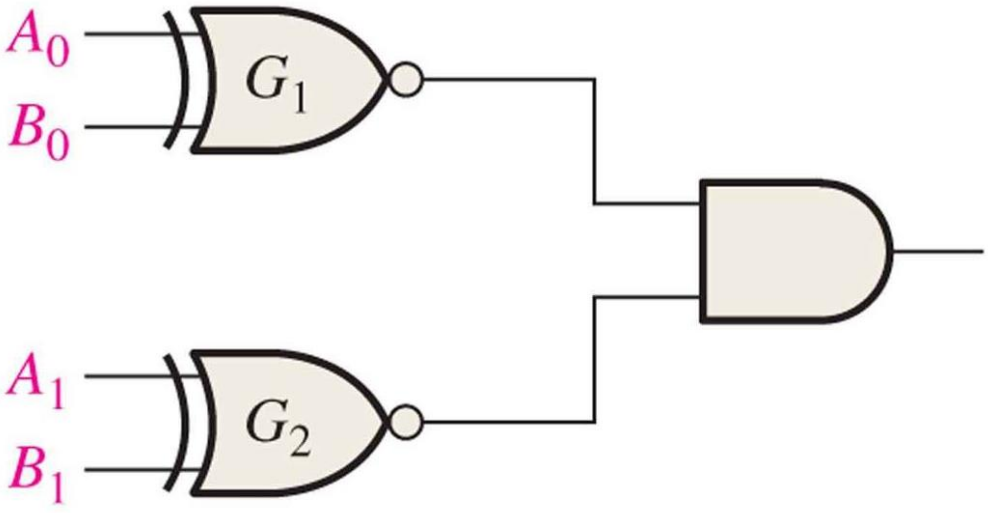

Figure 5

What is the function of the circuit shown in Figure 5?

Question 16 (3 marks)

What is the function of a decoder? Give a practical application of a decoder.

Question 17 (4 marks)

Each of the eight full-adders in an 8-bit parallel ripple carry adder exhibits the following propagation delays:

A to Sum (Σ) and $Carry_{out}$	40 ns
B to Sum (Σ) and $Carry_{out}$	40 ns
$Carry_{in}$ to Sum (Σ)	35 ns
$Carry_{in}$ to $Carry_{out}$	25 ns

Determine the maximum total time for the addition of two 8-bit numbers.

Question 18 (3 marks)

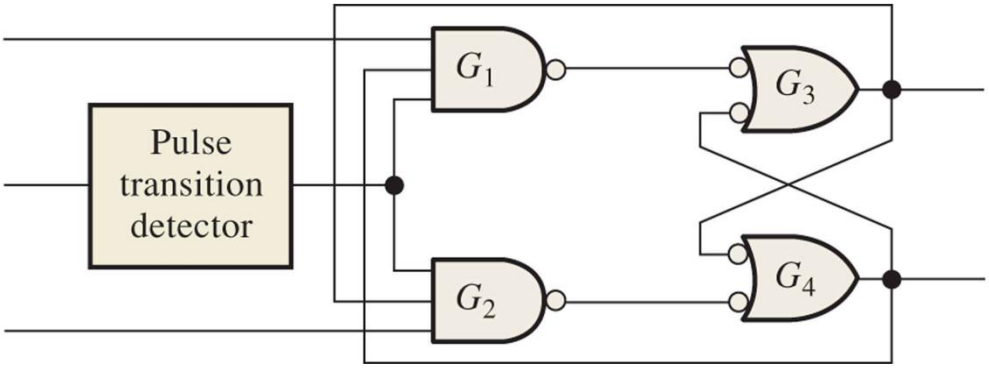

Figure 6

a) What is the circuit shown above called? (1 marks)

b) Give an example of an application of this circuit. (2 marks)

Question 19 (3 marks)

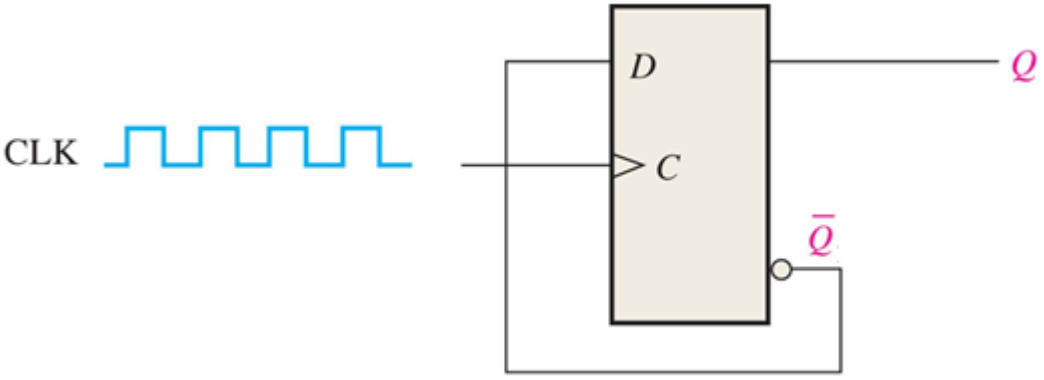

Figure 7

For the circuit shown in Figure 7, determine the *Q* output in relation to the clock. Assume *Q* is originally low.

Question 20 (3 marks)

What is meant by the set-up time of a flip-flop?

Question 21 (3 marks)

Design of a sequential circuit is often divided into six steps. Mention the steps.

Question 22 (4 marks)

Compare the circuits shown in Figures 8 and 9. Describe the function of both circuits and explain the differences, illustrated with a timing diagram.

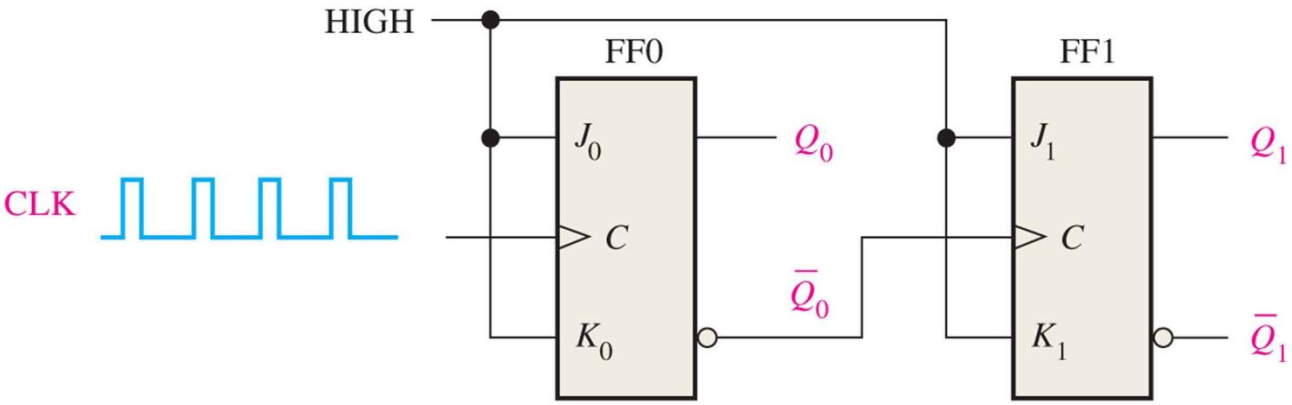

Figure 8

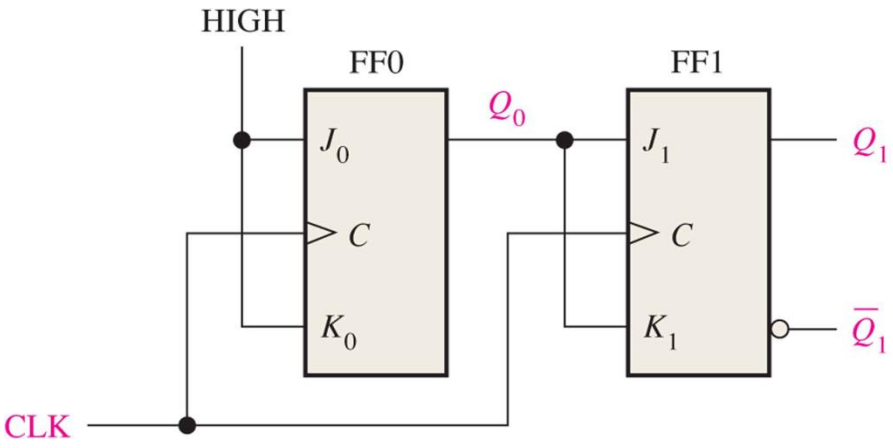

Figure 9

Question 23 (3 marks)

For the cascade counter shown in Figure 10, determine the frequency of the waveform at each point indicated by a circled number.

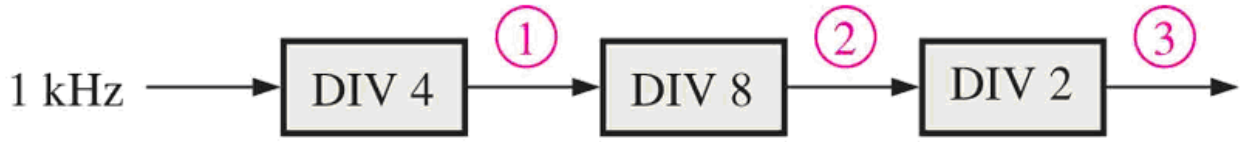

Figure 10

Question 24 (3 marks)

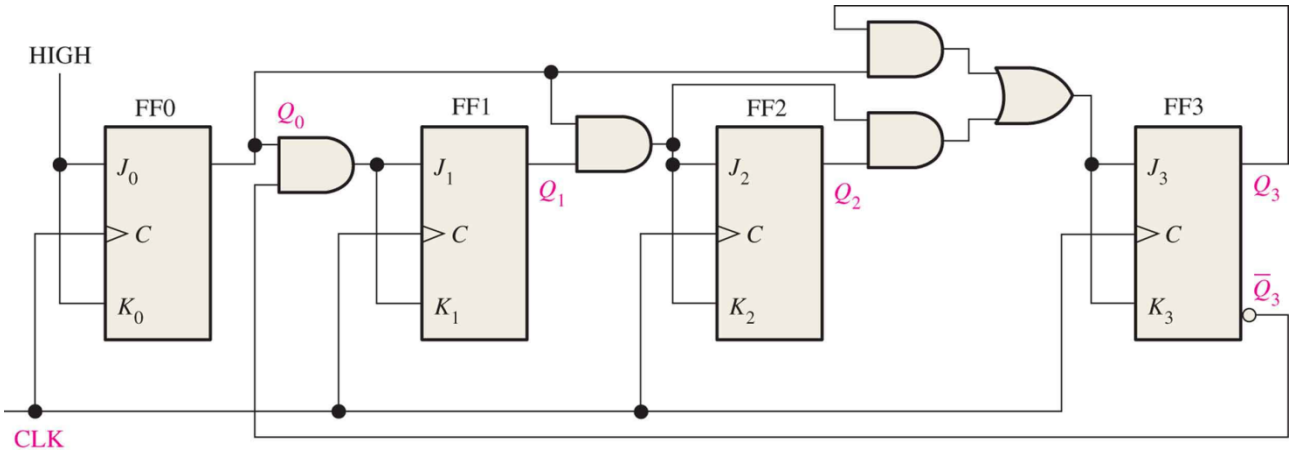

Figure 11

Explain how the circuit shown in Figure 11 works.

Question 25 (3 marks)

a) What is a glitch? (2 marks)

b) How can glitches be avoided? (1 mark)

Question 26 (3 marks)

Give three examples of applications of shift registers.

Question 27 (3 marks)

Explain how the circuit shown in Figure 12 can be modified to create a 4-bit serial in parallel out register.

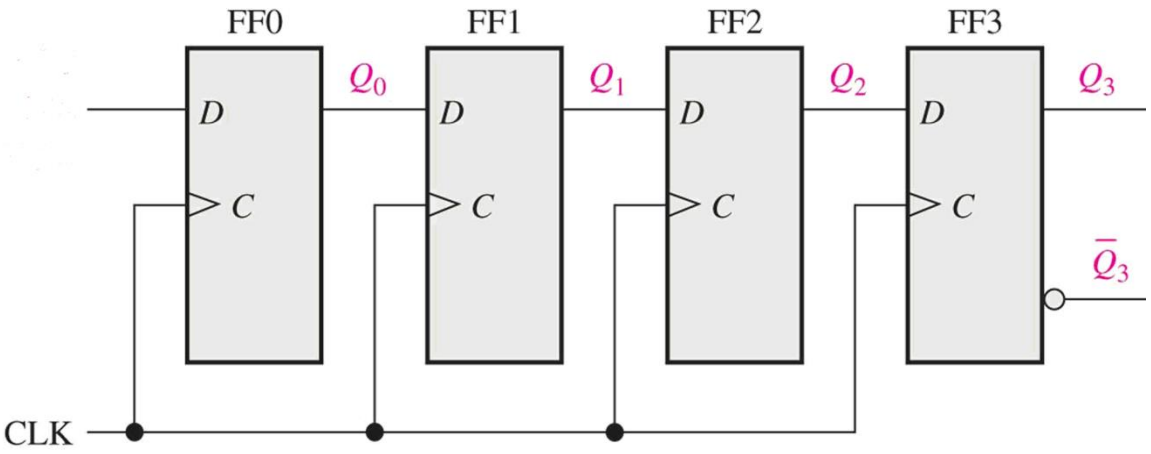

Figure 12

Question 28 (3 marks)

What are the basic components of a computer?

Question 29 (3 marks)

What is the purpose of a tri-state buffer?

Question 30 (3 marks)

What is the minimum number of processors required for multi-tasking? Explain your answer.